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Editorial: Special subject on the mechanical behavior of thermal protection materials and structures

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The thermal protection materials and structures are widely used in hypersonic vehicles for the purpose of thermal insulation, and their mechanical behavior is one of the key issues in design and manufacture of hypersonic vehicles. It is our great pleasure to present the seven papers in this special subject of *Theoretical & Applied Mechanics Letters* (TAML) and introduce the recent progresses on the mechanical behavior of thermal protection materials and structures by the authors. The thermal protection materials and structures include metal foams, ceramics coatings, superalloys, graphite, and C/SiC composites. Research works in this subject mainly focus on residual stress, elastic modulus, mechanical performance under thermal shock, failure criteria, and fatigue life, etc.

In order to characterize the mechanical behavior of the material under the thermal loading, Dafang Wu et al. studied the thermal protection performance of the superalloy honeycomb panels by using a self-developed transient aerodynamic thermal simulation system, and the thermal protection performance of superalloy honeycomb panel was tested at different transient heating rates ranging from 5°C/s to 30°C/s, with the maximum instantaneous temperature reaching 950°C. Furthermore, a 3D finite element method was established and a comparison between calculation and experimental results was carried out. As for the application of the advanced optics techniques, Ximin Chen et al. studied the residual stress and strain in thermal barrier coating under thermal shock cycles loading of 1 100°C using the microscopic digital image correlation (DIC) and micro-Raman spectroscopy. The evolution process of the residual stress under the thermal cycle load was analyzed in detail.

With respect to the C/SiC composites, Chengpeng Yang et al. proposed a damage-based failure criterion for C/SiC composites under plane stress state. The prediction result shows that the failure envelope given by D-criterion is lower than that from Tsai–Hill and Hoffman criteria, which reveals that damage-based criterion is reasonable for evaluation of damage-dominated failure strength. In addition, Yadong Zhou et al. investigated the temperature-dependence of acoustic fatigue life for a C/SiC panel. The Dirlik method is adopted to predict the fatigue life of a C/SiC panel at three different temperatures, respectively. Significant difference was observed from the results of numerical simulations between the fatigue lives of the panel in the given cases.

As for the characterization of mechanical properties, Baoqiao Guo et al. investigated the elastic constants of a three-point bending graphite at elevated temperature. Based on the heterogeneous deformation fields measured by the DIC technique, the elastic constants were extracted by using the virtual fields method. Jianguo Zhu et al. evaluated the microstructural and mechanical

properties of plasma-sprayed thermal barrier coating with high temperature treatment at 1 400°C by scanning electron microscopy and indentation. The results indicate that high temperature treatment will affect the values of the elastic modulus and hardness of porous ceramic coating mainly by changing the porosity.

Besides, Xiaolei Zhu et al. proposed a novel modeling method of cellular materials based on MATLAB image processing and synchrotron X-ray computed tomography scanning. By analyzing the established finite element model of aluminum foam, the compression behavior of aluminum foam is obtained, which is in good agreement with the experiments.

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